Instrument Science Report COS 2016-04(v2)

Summary of COS Cycle 23 Calibration Plan

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ABSTRACT

We summarize the calibration activities for the Cosmic Origins Spectrograph (COS) on the Hubble Space Telescope during Cycle 23 which ran from November 2015 through October 2016. We give an overview of the COS calibration plan, COS usage statistics and we briefly describe major changes with respect to the previous cycle. High-level executive summaries for each calibration program comprising Cycle 23 are also given here. Results of the analysis attached to each program are published in separate ISRs.

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1. Introduction

The Cosmic Origins Spectrograph (COS) was installed on the Hubble Space Telescope in May 2009. Cycle 23 was thus the seventh cycle of on-orbit operations for COS, running from November 2015 through October 2016. Each cycle, the COS team monitors the performance of the COS instrument through routine calibration that are designed to monitor instrument throughput, dispersion solutions, dark rates, and overall performance of the FUV and NUV channels. Updates to the COS reference files are made, when necessary, based on the results of the data analyses performed by the COS Team. The Cycle 23 calibration plan is composed of 10 regular calibration programs, 2 contingency programs and 3 special NUV calibration programs (cycle 23 only) that were designed to update the zero-points of the dispersion solutions for all NUV gratings.

In this document we give an overview of the overall COS usage with respect to other HST instruments and we summarize the distribution of COS FUV and NUV usage per mode and cenwave (Section 2). In Section 3, we give an overview of the 12 individual programs that comprise the COS Cycle 23 calibration plan and we summarize the changes applied to some of the regular Cycle 23 calibration programs compared to Cycle 22. Section 4 contains the high level executive summaries for the all calibration programs comprising the Cycle 23 COS plan.

2. Overview of COS Usage in Cycle 23

2.1 Prime Orbit Usage Statistics by HST Instrument

The HST orbit usage in terms of science time allocation is published yearly shortly after the phase II submission deadline and can be found at http://www.stsci.edu/hst/metrics/SiUsage/COS/. Table 1 summarizes the distribution of GO prime orbits and SNAP orbits among the HST instruments currently active. Based on phase II submission statistics for Cycle 23, the COS usage comprises ~18% (~889 orbits) of all approved GO prime orbits making COS the second most used instrument this cycle again. COS SNAP orbits represent ~7% of the total SNAP orbit allocation this cycle. Compared to Cycle 22, the COS GO prime usage has decreased slightly by ~2.5% and SNAP usage decreased by a similar percentage fraction.

Table 1: Cycle 23 allocation of science time amongst HST Instruments

Instruments	GO Prime Orbits Usage	GO SNAP Orbit Usage
ACS	15.7%	11.7%
COS	18.0%	7.3%
STIS	14.3%	6.7%
WFC3	52.0%	74.3%
FGS	<0.01%	0.0%

2.2 COS Prime Orbit Usage Statistics by Mode

Based on Cycle 23 phase II submissions, 98.5% of the total COS prime observing time consists of *science* exposures and the remaining 1.5 % of the total COS prime observing time consists of NUV Imaging target acquisition exposures. Of the 98.5% of COS *science* observing time, ~84% is used for COS FUV spectroscopic exposures and ~16% is used for NUV spectroscopic exposures. The breakdown among observing modes is summarized in Table 2. This distribution is very similar to that obtained in Cycle 22 and reflects the continued high demand for FUV spectroscopic capabilities from the HST user community.

Table 2: COS usage statistics by mode for Cycle 23

Configuration/Mode	**Prime Usage** (science exposures)	**SNAP Usage** (science exposures)
FUV / Spectroscopy	84.3%	100%
NUV / Imaging	<0.1%	0.0%
NUV / Spectroscopy	15.7%	---

2.3 COS Prime Orbit Usage Statistics by Mode and Grating

Table 3 summarizes the COS science observing time usage by mode and grating for the FUV and NUV channels. For the FUV channel, the prime orbit usage statistics in Cycle 23 are very similar to those in Cycle 22 for the G130M and 160M gratings. G130M remains the most used of the FUV gratings with 46% of prime science time. The blue mode cenwaves represent ~10.5 % of total G130M observing time with a breakdown among the blue mode cenwaves as follows: G130M/1222 (42.8%), G130M/1055 (6.7%) and G130M/1096 (50.5%). The Cycle 23 blue mode usage has increased sightly (~3%) compared to the Cycle 22 usage. Of note is the increase in the G139M/1096 usage by ~35% this cycle. The G140L remains the least used of the FUV gratings even though its prime usage increased slightly (~2%) compared to Cycle 22. The G140L/1105 is the most used cenwave and represents ~67 % of the total G140L science observing time (33% for the G140L/1280 configuration).

For the NUV channel, the prime orbit usage statistics in Cycle 23 are somewhat different from those in Cycle 22. The G285M and G230L gratings are not used in Cycle 23. The usage of the G185M has decreased by factor of 2 in Cycle 23 while the usage of G225M has increased slightly by ~4% compare to last cycle. Only a faction of a percent consists of NUV/Imaging science observations, a percentage fraction similar to all previous cycles as well.

In Cycle 23, SNAP observations are obtained only with the FUV channel, as in previous cycles. All the SNAP science observing time consists of G130M exposures this cycle.

Table 3: COS science usage statistics by mode and grating in Cycle 23

Configuration	Grating	Percentage of COS Prime Science Exposures		Percentage of COS SNAP Science Exposures	
		C22 (%)	C23 (%)	C22 (%)	C23 (%)
COS/FUV	G140L	13.5	15.4	31.1	--
(C23: 84.3% prime)	G130M	42.5	45.7	68.9	100
	G160M	27.6	23.2	---	--
COS/NUV	G230L	1.5	---	---	--
(C23: 15.7% prime)	G185M	8.0	4.4	---	--
	G225M	7.1	11.3	---	--
	G285M	---	---	---	--
	MIRROR A/B	0.1	<0.1	--	--

2.4 COS FUV Mode and FP-POS Distribution

Starting in Cycle 21, the COS FUV user community was requested to use all four FP-POS unless otherwise justified scientifically when observing with the COS FUV channel, in order to mitigate the effect of gain sag on the FUV detector. This requirement is actively monitored and enforced by the COS Team Contact scientists (CS) during the phase II technical review period. Figure 1 displays the FP-POS usage by grating and cenwave for Cycle 23. Note that this distribution is based on phase II submissions only and does not yet reflect any changes that might have been requested by the COS CS Team. Overall, the FP-POS usage is distributed quite evenly for a given grating/cenwave combination for all gratings, indicating that the COS FUV community has successfully integrated our requirement into their science observing plans this cycle again. The G130M/1291 remains the most used of all COS/G130M cenwaves. Noteworthy is the fact that the usage of the FP-POS=ALL feature was clearly the preferred dithering technique for G140L/1280 and for most of the G160M cenwaves in Cycle 23.

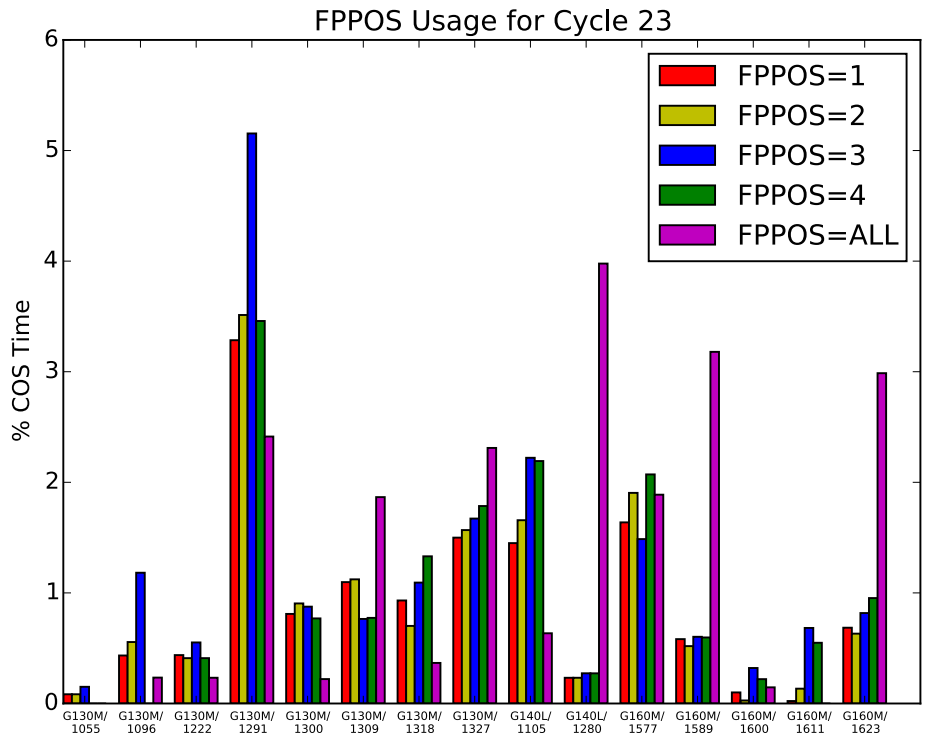

Figure 1: Cycle 23 distribution of FP-POS among COS modes. Relatively even FP-POS dithering was performed among COS FUV configurations following the COS Team requirements.

3. Overview of the Regular Cycle 23 Calibration Programs

The Cycle 23 calibration plan is composed of 10 regular calibration programs, 2 contingency programs designed to recover science operations in the FUV and NUV in case of an anomalous detector shutdown and 3 special calibration programs (cycle 23 only) designed to update the zero-point of the dispersion solutions for all NUV gratings. Table 4 provides a list of the calibration programs with their respective program IDs (Column 1) and title (Column 2). Column 3 reports the number of orbits executed[allocated] for each program, divided into external and internal orbits. Column 4 indicates the frequency of the visits for each monitoring program. Column 5 provides the reference to the ISR summarizing the data analysis and results obtained for each program and Column 6 lists the accuracy goal required for each program.

Most Cycle 23 programs are essentially continuations of the monitoring programs from the previous cycle. The COS/NUV TDS monitoring program was reduced from 6 to 4 external orbits as a trimestrial frequency of observations was not deemed necessary. The four COS FUV programs that were modified in Cycle 22 to accommodate the move of operations from to Lifetime Position 3 (LP3) have resumed their regular monitoring frequencies. In Cycle 23, 3 special calibration programs were approved to update the zero-point of the dispersion solutions for all COS/NUV gratings. We briefly summarize new programs below. Detailed descriptions will be provided in the program-related ISRs (see Table 4).

- *Update to the zero-point of the COS/NUV G185M dispersion solutions (PID14503)* is designed to obtain COS data for all cenwaves of the G185M using external target NGC330-B37. These data combined with existing STIS E140M/E230M data will allow for an update

the dispersion solution zero-points for all 3 stripes of all G185M cenwaves.

- *Update to the zero-point of the COS/NUV G225M and G285M dispersion solutions (PID14504)* is designed to obtain STIS data with E230M/1918 and G430M/3165 gratings using external target HD187691. These data combined with existing COS/NUV data and STIS/E230M(2707) data will allow us to update the dispersion solution zero-points for stripes A and B of select cenwaves of the G225M and G285M gratings.

- *Update to the zero-point of the COS/NUV G285M and G230L dispersion solutions (PID14505)* is designed to obtain STIS data with the G230M/2014 and G230MB/3115 gratings using external target HD6655. These data combined with existing COS data will allow us to update the dispersion solution zero-points for stripe A of G230L/2950-3000 and stripe C of G285M/2996-3018.

Table 4. High-level summary of regular Cycle 23 calibration programs

PID	Title	Orbits used Executed [Allocated]		Frequency	Products	Accuracy Achieved
		External	Internal			
14444	**COS NUV MAMA Fold Distribution**	--	1 [1]	1/yr	ISR 2017-09	<5% on peak location of fold distribution
14442	**COS NUV Detector Dark Monitor**	--	$46+6^{S}$ [52]	1/week	ISR 2017-12	0.2% in global dark rate uncertainty
14441	**COS NUV Spectroscopic Sensitivity Monitor**	4[4]	--	2x2/(L+M)	ISR 2017-13	S/N of 30 per resel
14443	**COS NUV Internal/External Wavelength Scale Monitor**	$1+1^{S}$ [2]	--	3x1	ISR 2017-08	1.7-3.7 pixels in wavelength scale accuracy
14440	**COS Imaging TA and Spectroscopic WCA-PSA/BOA offset Verification**	2^{S} [$2+1^{C}$]	--	2x1	ISR 2017-18	0.5 NUV pixel
14436	**COS FUV Detector Dark Monitor**	--	$235+25^{S}$ [260]	5/week/HV 2HV	ISR 2017-11	0.1% in global dark rate uncertainty
14435	**COS FUV Spectroscopic Sensitivity Monitor**	$20+3^{S}$ [$23+10^{C}$]	--	1x/month	TDS Ref file ISR 2017-10	<2/5% relative/absolute TDS calibration
14437	**COS FUV Internal/External Wavelength Scale Monitor**	$3+3^{H}$ [3]	--	1/yr	ISR 2017-07	✦scale accuracy: 5.7-7.5 pix G130M, 5.8-7.2 pix G160M, 7.5-12.5 pix G140L
14439	**COS FUV Detector Gain Maps**	--	4 [$4+2^{C}$]	Once per HV change	ISR 2017-14	~0.1 Pulse Height bins
14429	**COS observations of geo-coronal Lyman alpha emission (COS pure parallel)**	4^{P} [4^{P}]	--	4x1	ISR 2017-15	N/A
14503	**Constraining the zero-points of the COS/NUV wavelength solution - G185M**	3[3]	--	3x1	ISR 2017-02 STAN	1.7-3.7 pixels in wavelength scale accuracy
14504	**Constraining the zero-points of the COS/NUV wavelength solution - G225M and G285M**	1[1]	--	1x1	ISR 2017-02 STAN	1.7-3.7 pixels in wavelength scale accuracy

14505	**STIS data of HD6655 to derive COS G285M/G230L wavelength zero-points**	1[1]	--	1x1	ISR 2017-02 STAN	1.7-3.7 pixels in wavelength scale accuracy
14446	**COS NUV recovery after Anomalous Shutdown**	--	0 [4[C]]	Contingency	None	N/A
14445	**COS FUV Recovery After Anomalous Shutdown**	--	0 [17[C]]	Contingency	None	N/A

[C] Contingency orbits, [P] Parallel orbits, [H] HOPR, [S] Scheduled

Reference files are updated "as needed" to maintain instrument calibration within the required specifications. For several programs, regularly updated reference files are produced. For many others, results are either posted on the web, or simply documented in their respective ISR. Currently available reference files can be found at the following web address: www.stsci.edu/hst/observatory/cdbs/SIfileInfo/COS/reftablequeryindex. Other products resulting from the calibration program include COS Instrument Science Reports (ISRs), COS Technical Instrument Reports (TIRs), and updates to the COS Instrument (IHB) and Data (DHB) Handbooks. Links to these documents can be found at: www.stsci.edu/hst/cos/documents . Note that TIRs are only available on the internal STScI web site. In order to retrieve TIRs a document from outside STScI, a request needs to be sent to help@stsci.edu.

4. Executive Summary for each Individual Program

We provide a high-level summary of the purpose, requirements and orbit allocation for each of the 15 calibration programs comprising the regular Cycle 23 calibration plan. Results of the monitoring analysis are reported separately in program-specific ISRs (see Table 4 for reference number).

Program ID 14435: COS FUV Spectroscopy Sensitivity Monitor

PI: Gisella De Rosa

Analysis Lead, Others: Gisella De Rosa

Purpose	Monitor the sensitivity of each FUV grating mode to detect any change due to contamination or other causes. The FUV gratings are the most heavily used modes on COS and have also experienced several changes in the time-dependent spectroscopic sensitivity since launch. These trends are grating, segment, and wavelength dependent.
Description	To track the TDS as a function of wavelength we obtain exposures with all FUV gratings every month. There are 2 types of monitoring sequences which occur on alternating months. (i) Full monitoring sequence every other month (except May – Jul when GD71 is unavailable): 3 orbits in 2 visits. The 1 orbit visit (GD71) covers the G130M/1096/FUVB, G160M/1577/FUVA, and G160M/1623/FUVA modes. The 2 orbit visit (WD0308) covers G130M/1222, G130M/1291, G130M/1327, G130M/1055/FUVA, G160M/1577/FUVB, G160M/1623/FUVB, G140L/1105, G140L/1280 modes. These comprise the reddest and bluest central wavelengths of each grating with additional coverage of the G130M blue modes. (ii) Reduced monitoring sequence in alternating months: 1 orbit visit (WD0308) to monitor the complete wavelength range of the standard modes using one central wavelength per grating. The modes covered are G130M/1291, G160M/1623, and G140L/1280.
Fraction GO/GTO Programs Supported	84% of COS exposure time
Resources Required: Observations	23 external orbits + (10 contingency external orbits needed if changes in trends are seen during cycle)
Resources Required: Analysis	10 FTE weeks
Products	Time-Dependent Sensitivity reference file as necessary, update to ETC throughputs, the COS monitoring webpages, and a summary in the end of cycle ISR
Accuracy Goals	- SNR of 15 per resel at wavelength of least sensitivity for the standard modes, SNR of 25 per resel at wavelength of most sensitivity for the blue modes. For the blue modes, this will ensure S/N > 15 for l> 1030 Å for 1096/FUVB, l>1130 Å for 1055/FUVA and 1222/FUVB - TDS calibration better than 2% for standard modes and 10% for blue modes
Scheduling & Special Requirements	• Reduced monitoring sequence should occur every 2 months starting in November 2015 • Complete monitoring sequence should occur every 2 months starting in December 2015 • The FUVA turn-off of the GD71 visit should be hidden in the GS-ACQ • GD71 is unschedulable May – July 2016
Changes from Cycle 22	Reduced by 3 external orbits as LP3 reconnection is not required.

Program ID 14436: COS/FUV Detector Dark Monitor

PI: Justin Ely

Analysis Lead, Others: Justin Ely, Mees Fix

Purpose	Perform routine monitoring of FUV XDL detector dark rate. The main purpose is to look for evidence of a change in the dark rate, both to track on-orbit time dependence and to check for a developing detector problem.
Description	Monitor the FUV detector dark rate by taking TIME-TAG science exposures with no light on the detector. Five times every week a 22-min exposure is taken with the FUV detector with the shutter closed. The length of the exposures is chosen to make them fit in Earth occultations. All orbits < 1800s.
Fraction GO/GTO Programs Supported	84% of COS total exposure time
Resources Required: Observations	260 internal orbits. All orbits < 1800s.
Resources Required: Analysis	4 FTE weeks
Products	Provide ETC and IHB dark rate estimates, along with weekly monitoring for changes and a summary in the end of cycle ISR. Update monitor and COS webpages. As allowed by resources and necessitated by data quality: improve dark subtraction method and update bad-pixel tables.
Accuracy Goals	Obtain enough counts to track 1% level changes on timescales of ~1-3 months.
Scheduling & Special Requirements	5x / week at nominal HV during Earth occultation.
Changes from Cycle 22	Reduced total request by 170 orbits. The need to monitor dark rate at 2 operation voltages is not required in Cy23 based on this cycle usage.

Program ID 14437: COS FUV Internal/External Wavelength Scale Monitor

PI: Paule Sonnentrucker

Analysis Lead, Others: Paule Sonnentrucker

Purpose	This program monitors the offsets between the wavelength scale set by the internal wavecal versus that defined by absorption lines in external target AV75 obtained through the PSA.
Description	This program monitors the offset between the internal and external wavelength scales: this offset is referred to as "DELTA" in the wavelength dispersion reference file and corrects for the shift between the WCA and PSA in TV03 versus the shift between the WCA and PSA in orbit : (WCA-PSA)_TV03 - (WCA-PSA)_orbit. Analysis of TV data indicates that this DELTA (offset) is cenwave and FP-POS independent for a particular grating, but it is grating dependent. To verify and monitor this dependency, this program observes the G130M/1096-1222-1291-1327, G160M/1577-1623 and G140L/1105-1280 cenwaves at different FP-POS. The Cycle 21 structure is restored starting in Cycle 23.
Fraction GO/GTO Programs Supported	84% of COS total exposure time.
Resources Required: Observations	3 external orbits. Schedulability set to 30% to fit all observations within requested orbits.
Resources Required: Analysis	4 FTE weeks
Products	Update of wavelength dispersion reference file if necessary, ISR, and a summary in the end of cycle ISR.
Accuracy Goals	G140L 150km/s, 7.5-12.5 pixels G130M 15km/s, 5.7-7.5 pixels G160M 15km/s, 5.8-7.2 pixels
Scheduling & Special Requirements	These observations are taken once per cycle. ORIENT is set to avoid bright field targets.. External target used is AV75 (target used since Cy 20).
Changes from Cycle 22	Restore full monitoring program for a total of 3 external orbits as in cycles prior to Cycle 22.

Program ID 14439: COS FUV Detector Gain Maps

PI: David Sahnow

Analysis Lead, Others: David Sahnow

Purpose	Obtain gain maps of the FUV detector either before and after changes to the nominal high voltage levels, or during the cycle based on detector usage. These data will be used to check that the expected modal gain is achieved for HV changes, and to track the dependence of modal gain as a function of time.
Description	Use the deuterium lamp to illuminate the appropriate LP2 or LP3 region of the COS FUV detector at the following times: • LP3 standard modes: Immediately before and after the Segment B HV is increased (2 orbits) • LP3 G130M/1222: Snapshot of gain map to monitor the change since moved to LP3 (1 orbit) • LP2 Blue Modes: Snapshot of gain map to monitor the change since moved to LP3 (1 orbit) • Contingency for LP3 G130M/1222: After any change to the HV for this mode (1 orbit) • Contingency for LP2 Blue Modes: After any change to the HV for this mode (1 orbit)
Fraction GO/GTO Programs Supported	84%
Resources Required: Observations	4 internal orbits 2 internal contingency orbits
Resources Required: Analysis	1 FTE week. Existing CCI / gain map procedures will be used to process these data part of normal gain monitoring.
Products	Gain map files. These will be used to update the GSAGTAB (and possibly the BPIXTAB), and also improve the models of gain vs. HV and gain vs. exposure.
Accuracy Goals	0.1 pulse height bin
Scheduling & Special Requirements	Immediately before and immediately after any HV change, and no earlier than Feb 2016.
Changes from Cycle 22	Reduced by 1 external and 1 internal orbits. No Lifetime Position change this cycle

Program ID 14429: COS Observations of Geocoronal Lyman-alpha Emission COS - Pure Parallel

PI: Sean Lockwood

Analysis Lead, Others: Sean Lockwood

Purpose	To obtain COS G130M spectra of geocoronal Lyman-α and other airglow emission lines with S/N ratios sufficient to trace the line wings of Lyman-α
Description	Obtain parallel airglow spectra with COS/FUV to characterize the profile of airglow lines. Visible in G130M/1291: H I 1215.67; O I 1302.2, 1304.9, 1306.0, 1355.6, 1358.5; N I 1199.5-1200.7
Fraction GO/GTO Programs Supported	43% (G130M observations)
Resources Required: Observations	4 external parallel orbits (in parallel with STIS MAMA TDS and focus monitor) in Cy 23 ~0.75% of lifetime at brightest Ly-α pixel for each FP-POS (2 FP-POS used) in Cy 23
Resources Required: Analysis	1 FTE week
Products	Update of the website listing airglow datasets. Observers must reduce these data themselves. Summary in end of cycle ISR.
Accuracy Goals	SN = 1.5 per pixel at 1213 A
Scheduling & Special Requirements	Parallel with STIS MAMA TDS monitor. Roll angle must be chosen to avoid objects in the COS PSA or BOA apertures.
Changes from Cycle 22	Requirements have been achieved (10,000s) for 1105A, 1291A, and 1327A at LP2. In Cy23, we will continue accumulating data for 1291A (most used cenwave) and 1327A at LP3. We plan to continue in future cycles to reach S/N requirement and monitor other cenwave (as was done at LP2).

Program ID 14440: COS Target Acquisition Monitoring

PI: Steven Penton

Analysis Lead, Others: Steven Penton

Purpose	Measure/monitor the WCA-to-PSA/BOA offsets used for imaging target acquisition (TA), and WCA-to-PSA for spectroscopic TAs
Description	There are 4 NUV ACQ/IMAGE mechanism combinations: 2 science apertures (SAs: PSA & BOA) x 2 mirror modes (MIRRORA & MIRRORB). During SMOV, the WCA-to-PSA+MIRRORA offset was determined by an aperture scan; the other WCA-to-SA offsets were bootstrapped from this offset. Changes in the PSA+MIRRORA-to-PSA+MIRRORB offset are monitored in the Focal Plane Calibration program (SI-FGS Alignment; 14035 for C22). All other spectroscopic WCA-PSA offsets, all WCA-SA imaging offsets, and co-alignment for all ACQ/IMAGE modes are monitored by the present program. It obtains PSA spectra of the targets with all gratings to track any changes in the spectroscopic WCA-to-PSA offsets.
Fraction GO/GTO Programs Supported	100% of COS total exposure time (all COS exposures depend on WCA-SA offsets)
Resources Required: Observations	2 external one-orbit visits + 1 external orbit contingency visit. The PSA+MIRRORA and PSA+MIRRORB co-alignment is periodically tested in the SIAF file verifications of HST program 14035. If this program has not been run with the current SIAF file, a contingency visit would be needed to measure the PSA+MIRRORA-to-PSA+MIRRORB offset
Resources Required: Analysis	2 FTE weeks for analysis, and verifying WCA-to-SA offsets. Should changes be warranted to existing offsets, additional effort will be needed, as this requires changes to the COS flight software (FSW).
Products	Updated NUV imaging WCA-to-SA offsets, NUV & FUV Spectroscopic WCA-to-PSA offsets and summary in the end of cycle ISR.
Accuracy Goals	Imaging WCA-to-SA offsets need to be known to better than 0.5 NUV pixels in both dispersion and cross-dispersion (XD). Spectroscopic WCA-to-PSA offsets to 0.5 XD pixel.
Scheduling & Special Requirements	Should be executed annually and after each COS SIAF adjustment.
Changes from Cycle 22	No major change. Minor tweaks to order exposures and increase observing efficiency. High priority FUV WCA-to-PSA offsets moved from BOA+MIRRORB visit to BOA+MIRRORA visit, as BOA+MIRRORA ACQ/IMAGES are slightly more accurate than BOA+MIRRORB ACQ/IMAGEs (due to overlap of MIRRORB images.)

Program ID 14441: NUV Spectroscopic Sensitivity Monitor

PI: Jo Taylor

Analysis Lead, Others: Jo Taylor

Purpose	Monitor sensitivity of each NUV grating mode to detect any change due to contamination or other causes. The NUV gratings on COS degrade with a rate that has been steady since the start of on-orbit operations, with the bare-Aluminum grating degrading at a faster rate (~3 and 11%/yr) than the MgF_2 coated gratings (~0%/yr). Additionally, track the time dependence of the sensitivity as a function of wavelength.
Description	Obtain exposures in all NUV gratings – G230L (target: WD1057+719), G185M, G225M, and G285M (target: G191B2B) – 2 times a year. We will monitor the following modes: G230L/2635, G230L/2950, G185M/1786, G185M/1921, G225M/2186, G285M/2617, and G285M/3094. These central wavelengths constitute the reddest and bluest central wavelengths containing only first order light with the exception of the G225M. In Cycle 23, we continue monitoring these specific cenwaves to verify that the overall trends remain unchanged.
Fraction GO/GTO Programs Supported	15% of COS exposure time
Resources Required: Observations	4 external orbits with 2 visits of 2 orbits each.
Resources Required: Analysis	5 FTE weeks
Products	Time-Dependent Sensitivity Reference File and a summary in the end of cycle ISR. As permitted by resources and data quality: add wavelength dependence to TDS reference files
Accuracy Goals	Characterize evolution of TDS within 2% .
Scheduling & Special Requirements	Observe at 6 month intervals.
Changes from Cycle 22	Program reduced by 2 orbits

Program ID 14442: COS/NUV Detector Dark Monitor

PI: Justin Ely

Analysis Lead, Others: Justin Ely, Mees Fix

Purpose	Perform routine monitoring of the MAMA detector dark current. The main purpose is to look for evidence of a change in the dark rate, both to track on-orbit time dependence and to check for a developing detector problem.
Description	Monitor the NUV detector dark rate by taking TIME-TAG science exposures without illuminating the detector. Twice every other week a 22-min exposure is taken with the NUV (MAMA) detector with the shutter closed. The length of the exposures is chosen to make them fit in Earth occultation. All orbits < 1800s.
Fraction GO/GTO Programs Supported	15% of COS total exposure time.
Resources Required: Observations	52 internal orbits. All orbits < 1800s.
Resources Required: Analysis	4 FTE weeks
Products	Provide ETC and IHB dark rate estimates, along with weekly monitoring for changes and a summary in the end of cycle ISR. As allowed by resources and necessitated by data quality: update bad-pixel tables. Update monitor webpage
Accuracy Goals	30%
Scheduling & Special Requirements	Twice every other week, in Earth occultation
Changes from Cycle 22	No changes.

Program ID 14443: COS NUV Internal/External Wavelength Scale Monitor

PI: Paule Sonnentrucker

Analysis Lead, Others: Paule Sonnentrucker

Purpose	This program monitors the offsets between the wavelength scale set by the internal wavecal versus that defined by absorption lines in external target HD6655 obtained with the PSA.
Description	This program monitors the offsets between the internal and external wavelength scales: this offset is referred to as "DELTA" in the wavelength dispersion reference file and corrects for the shift between the WCA and PSA in TV03 versus the shift between the WCA and PSA in orbit: (WCA-PSA)_TV03 - (WCA-PSA)_orbit. Analysis of TV data indicates that this DELTA is cenwave and FP-POS independent for a particular grating, but it is grating and stripe dependent. To verify and monitor this dependency, this program observes some cenwaves at different FP-POS. Failure Investigation for V02 of C21 and C22 program revealed chronic issues with GS in this field of view and demonstrated that verification can be done with 2 epochs alone.
Fraction GO/GTO Programs Supported	15 % of COS total exposure time.
Resources Required: Observations	2 external orbits with 2 visits of 1 orbit each
Resources Required: Analysis	3 FTE weeks
Products	Update to wavelength dispersion reference file as needed, ISR, and a summary in the end of cycle ISR.
Accuracy Goals	G230L 175km/s, 2.0-3.7 pixels G185M 15km/s, 1.7-2.4 pixels G225M 15km/s, 2.3-3.2 pixels G285M 15km/s, 2.3-3.5 pixels
Scheduling & Special Requirements	2 external orbit every 6 months. BETWEEN are added to take data within 2 visibility periods with known, good GS.
Changes from Cycle 22	Reduced by 1 external orbit. Optimized TA strategy to mitigate GS issues in the field since accurate target centering is critical to this program. Verification can be performed with 2 external visits alone.

Program ID 14444: COS NUV MAMA Fold Distribution

PI: Thomas Wheeler

Analysis Lead, Others: Thomas Wheeler, Alan D. Welty (CoI)

Purpose	The fold analysis provides a measurement of the distribution of charge cloud sizes incident upon the anode providing some measure of changes in the pulse-height distribution of the MCP and, therefore, MCP gain.
Description	While globally illuminating the detector with a flat field, the valid event (VE) rate counter is monitored while various combinations of row and column folds are selected.
Fraction GO/GTO Programs Supported	~50% of COS (includes COS/FUV programs with NUV TA acquisitions)
Resources Required: Observations	1 internal orbit
Resources Required: Analysis	0.5 FTE day.
Products	The results are sent to the COS Team and V. Argabright (Ball Aerospace)
Accuracy Goals	5% accuracy on the peak position of the fold distribution
Scheduling & Special Requirements	This proposal is executed annually.
Changes from Cycle 22	No change.

Program ID 14503: Constraining the zero-point of the COS/NUV wavelength solution- G185M

PI: Paule Sonnentrucker
Analysis Lead, Others: Paule Sonnentrucker

Purpose	Update the zero-point of the COS/NUV dispersion solutions for G185M.
Description	Obtain COS/NUV G185M spectra for all cenwaves using external target NGC330-B37 to update the zero-point of the dispersion solutions with on-orbit values for stripes A and B. Archival STIS E140M/E230M data will be used to support analsyis.
Fraction GO/GTO Programs Supported	~15% of COS
Resources Required: Observations	3 external orbits
Resources Required: Analysis	3 FTE weeks
Products	Reference file and IHB updates, STAN, Summary ISR
Accuracy Goals	S/N=10 in stripe with lowest counts. Accuracy in absolute wavelength scale of 1.7-3.5 pixels
Scheduling & Special Requirements	ORIENT set to avoid 2 bright field stars. Execute no later than 31 July, 2016
Changes from Cycle 22	New program. Cycle 23 only.

Program ID 14504: Constraining the zero-point of the COS/NUV wavelength solution- G225M and G285M

PI: Julia Roman-Duval
Analysis Lead, Others: Rachel Plesha

Purpose	Update the zero-point of the COS/NUV dispersion solutions for G225M and G285M.
Description	Obtain STIS E230M/1918 and G430M/3165 spectra of external target HD187691 to update the zero-point of the dispersion solutions with on-orbit values for stripes A and B of the COS/NUV G225M and stripe C of the G285M gratings. Existing archival COS data for this target and STIS/E230M(2707) will be used to support analsyis.
Fraction GO/GTO Programs Supported	~15% of COS
Resources Required: Observations	1 external orbit
Resources Required: Analysis	3 FTE weeks
Products	Reference file and IHB updates, STAN, Summary ISR
Accuracy Goals	Accuracy in absolute wavelength scale of 1.7-3.5 pixels
Scheduling & Special Requirements	Execute no later than 31 July, 2016
Changes from Cycle 22	New program. Cycle 23 only.

Program ID 14505: STIS data of HD6655 to derive COS G285M/G230L wavelength zero-points

PI: Cristina Oliveira
Analysis Lead, Others: Rachel Plesha

Purpose	Update the zero-point of the COS/NUV dispersion solutions for G230L/G285M.
Description	Obtain STIS G230M/2014 and G230MB/3115 spectra of external target HD6655 to update the zero-point of the dispersion solutions with on-orbit values for stripe A of G230L/2950-3000 and srtipe C of G285M/2996-3018, respectively. Existing archival COS data will be used to support analsyis.
Fraction GO/GTO Programs Supported	~15% of COS
Resources Required: Observations	1 external orbit
Resources Required: Analysis	3 FTE weeks
Products	Reference file and IHB updates, STAN, Summary ISR
Accuracy Goals	S/N=15 at 1980. Accuracy in absolute wavelength scale of 1.7-3.5 pixels
Scheduling & Special Requirements	Execute no later than 31 July, 2016
Changes from Cycle 22	New program. Cycle 23 only.

Change History for COS ISR 2016-04

Version 1: 20 September 2016 – Original Document
Version 2: 30 August 2017 – Updated with summary ISR numbers